The positioning services of the Norwegian Mapping Authority

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Receiver Network

- First station established in 1993
- Positioning services launched in 2001
- National coverage (max 70 km baselines) in 2011
- 2012 and after: Network densified in selected regions
- Currently ~200 stations in mainland Norway
- GNSS observations at 1 Hz sample rate are transmitted in real-time to the control centre

Receiver & antenna hardware

Typical antennas are Choke Ring antennas or Zephyr Geodetic antennas from Trimble. Most receivers in the network are Trimble NetR9.

Examples of antenna mounts:

5 meter steel mast
(Site: Dagali)

On the roof of a concrete building
(Site: Skollenborg)

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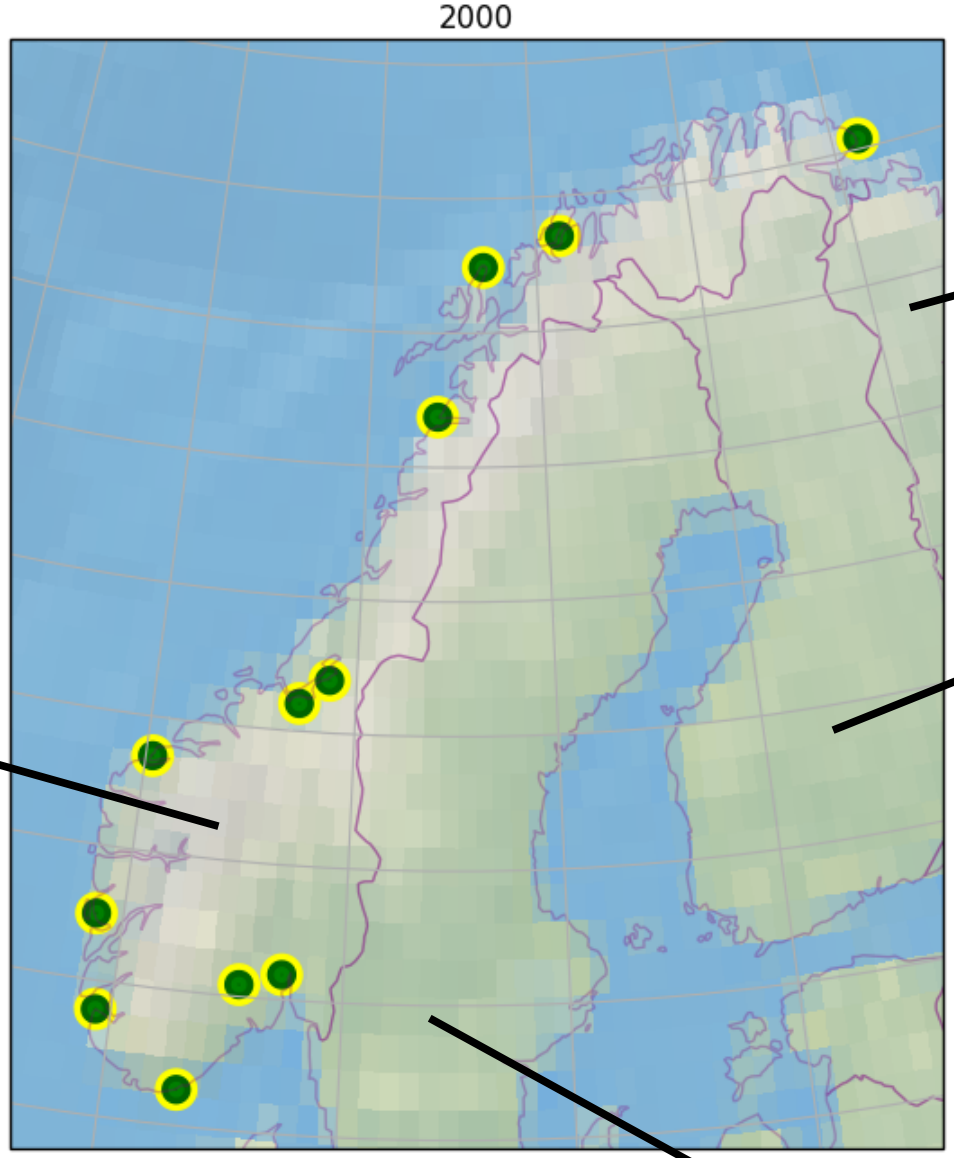
Receiver Network Year 2000



Russia

Finland

Norway

Sweden

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Receiver Network
Year 2016

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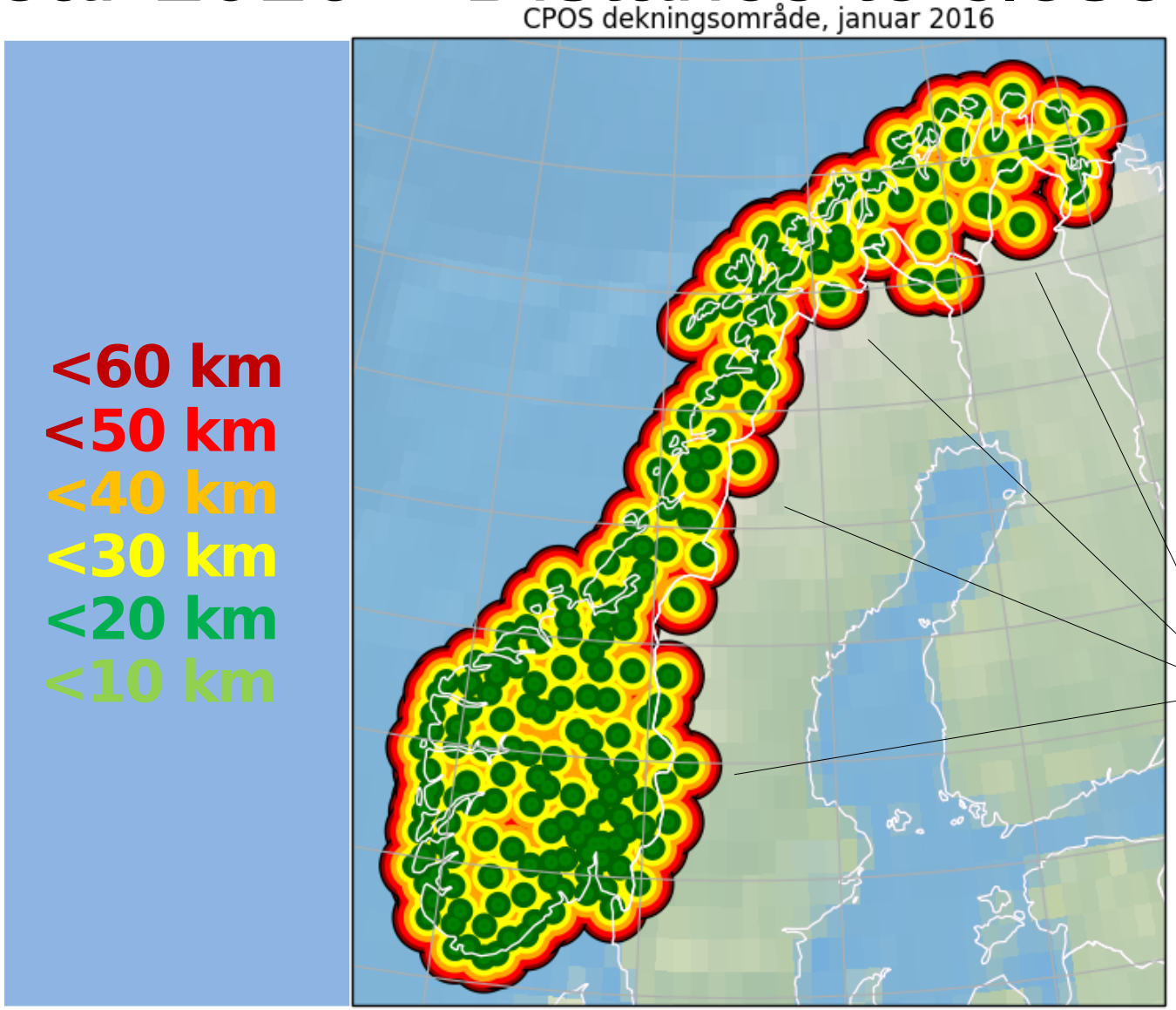
Receiver Network
Year 2016 – Distance to closest receiver



Data sharing with Sweden and Finland close to the border to provide continuous coverage

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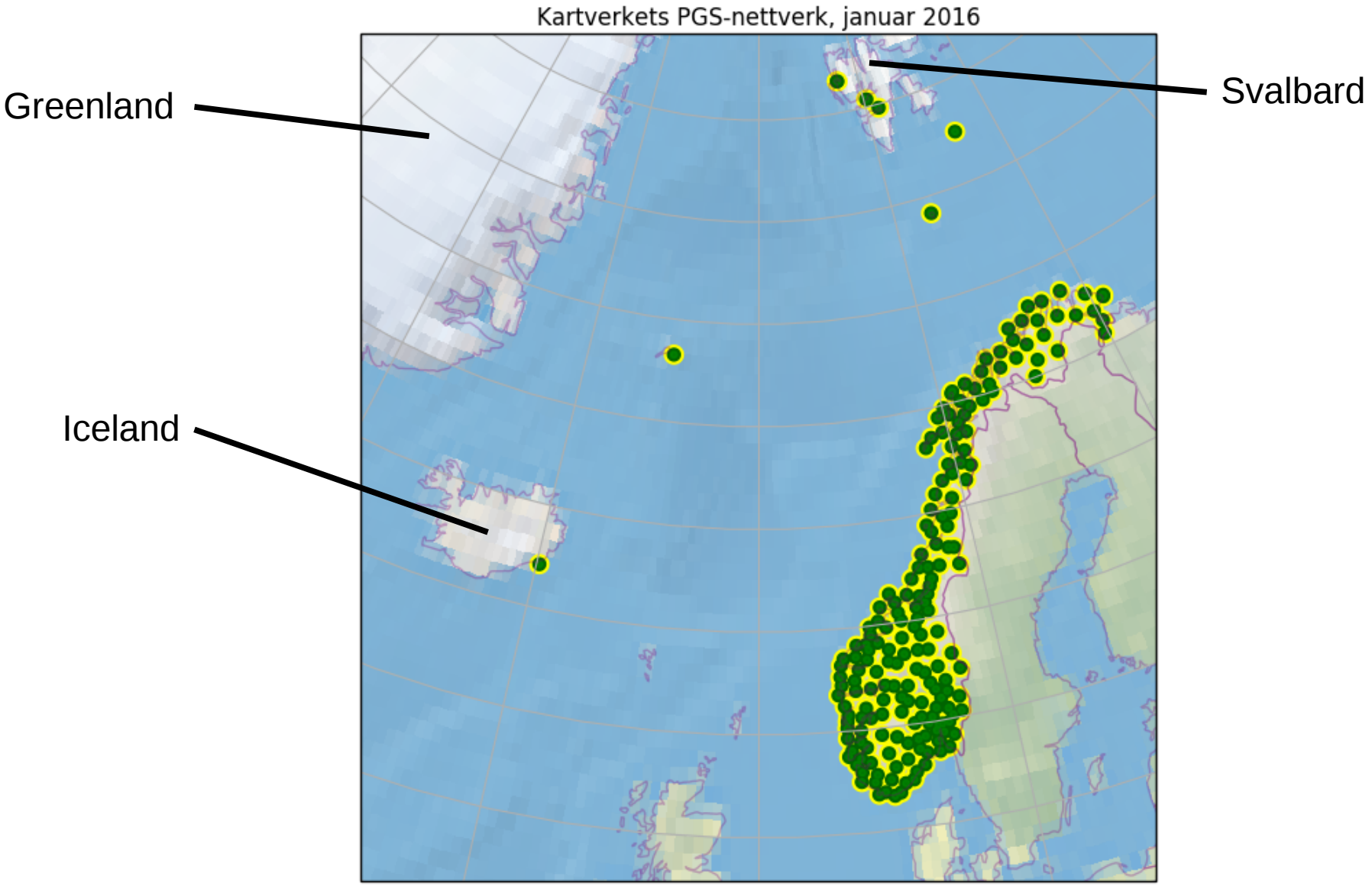
Receiver Network

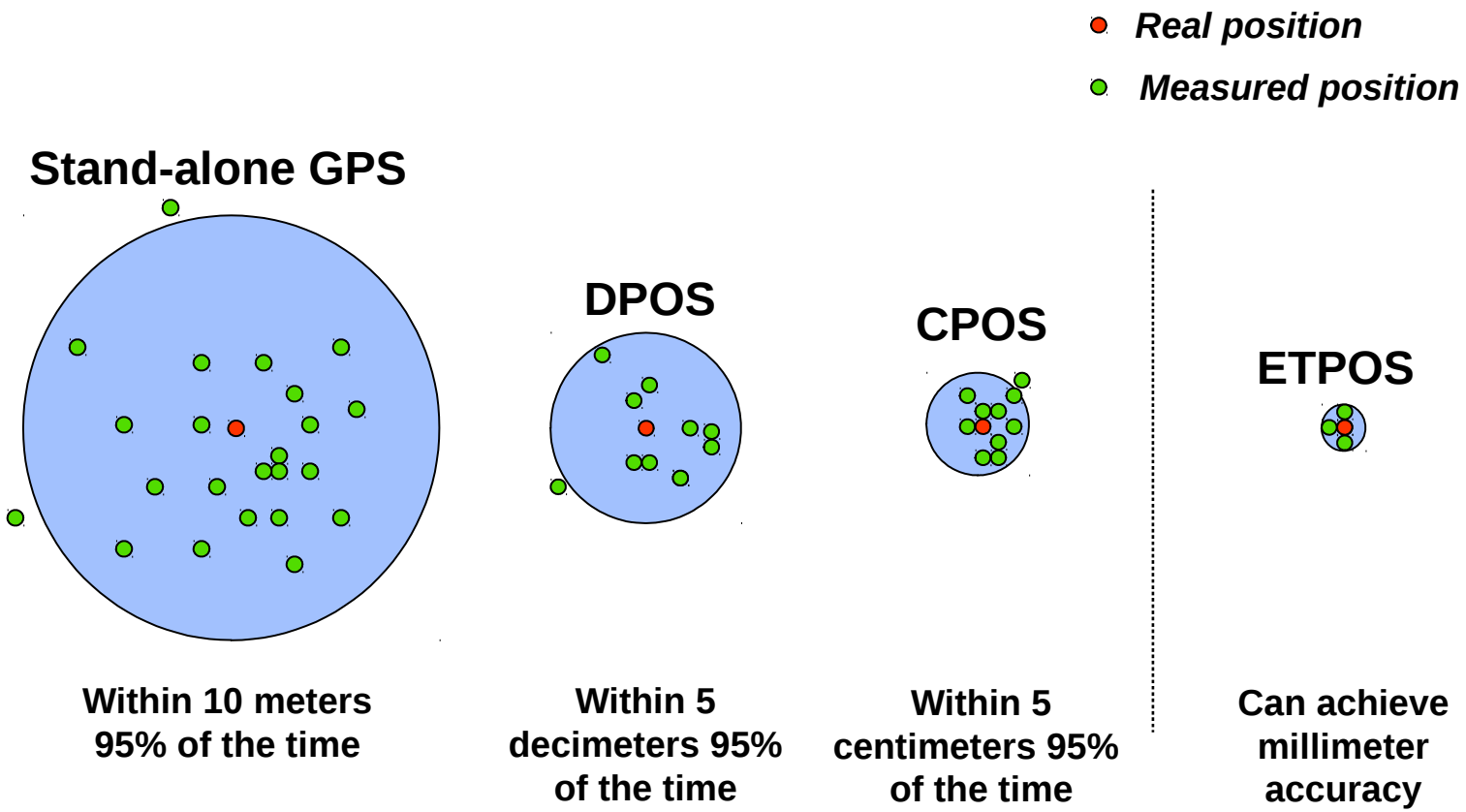
Receiver sites outside of the mainland



Positioning services

- **CPOS**
  - Launched in 2001, using 6 stations in the Oslo region
  - Network Real-Time Kinematic (RTK) service
  - Constructs Virtual Reference Stations (VRS) near the user location and transmits corrections data to the user as if the station existed.
  - Uses dual-frequency code & phase from GPS and GLONASS (upgrades to include Galileo are in progress)
  - ~2 cm accuracy (assuming good measurements conditions)
- **DPOS**
  - Launched in 2001, using 12 stations distributed over mainland Norway
  - Differential GNSS (DGNSS) service
  - Uses single-frequency code & phase from GPS and GLONASS
  - decimeter-level accuracy
- **ETPOS**
  - Access to data files from our receivers (RINEX format)
  - Access to information about the receivers (primarily accurate receiver coordinates) that may be needed when using the data
  - Can achieve millimeter-level accuracy

Positioning services



ETPOS – Data for post-processing

- Format: RINEX 2.11
- RINEX 3 format files generated for some receivers. (RINEX 3 solution is under development)
- 1 second resolution and 30 second resolution
- Access is included in CPOS subscription, or can be bought separately
- Access is to files from the most recent three months. Older data can be made available on a case-by-case basis.
- Research and education projects get files for free
- http://kartverket.no/Posisjonstjenester/

The Control Centre

- Staffed during work hours
- Monitors all positioning services, the data archive, and some other services and instrumentation (including webcams at Svalbard)

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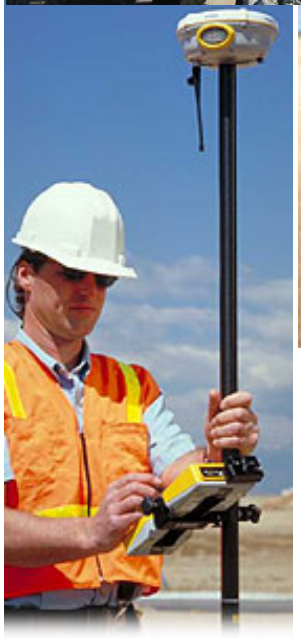
Users of the services

- **CPOS**
  - Total subscriptions: 3805
  - 355 of those are free subscriptions for:
    - Universities
    - Schools
    - Research
    - GNSS equipment vendors
    - Internal NMA use
  - Peak simultaneous user connections: 700
- **DPOS**
  - Total subscriptions: 167 (55 of those are free subscriptions)
- **ETPOS**
  - Access is included in CPOS subscription
  - Some users (very few) buy access to ETPOS only.

Main user groups of CPOS



- Construction (Buildings/roads/other)
- Surveying
- Maritime activities (Near the coast)
- Open-pit mining
- Registration/documentation (Objects, real-estate, borders, etc)
- Agriculture
- Forestry

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Main user groups of CPOS

Example of use: Excavator

GNSS is used to accurately position one or more receivers mounted on the vehicle.

Sensors on the vehicle can accurately position the bucket relative to the GNSS receiver(s).

Computer displays can then show in real-time how the bucket is positioned in relation to planned activites, underground cables/pipes, etc

Foto: Morten Brun

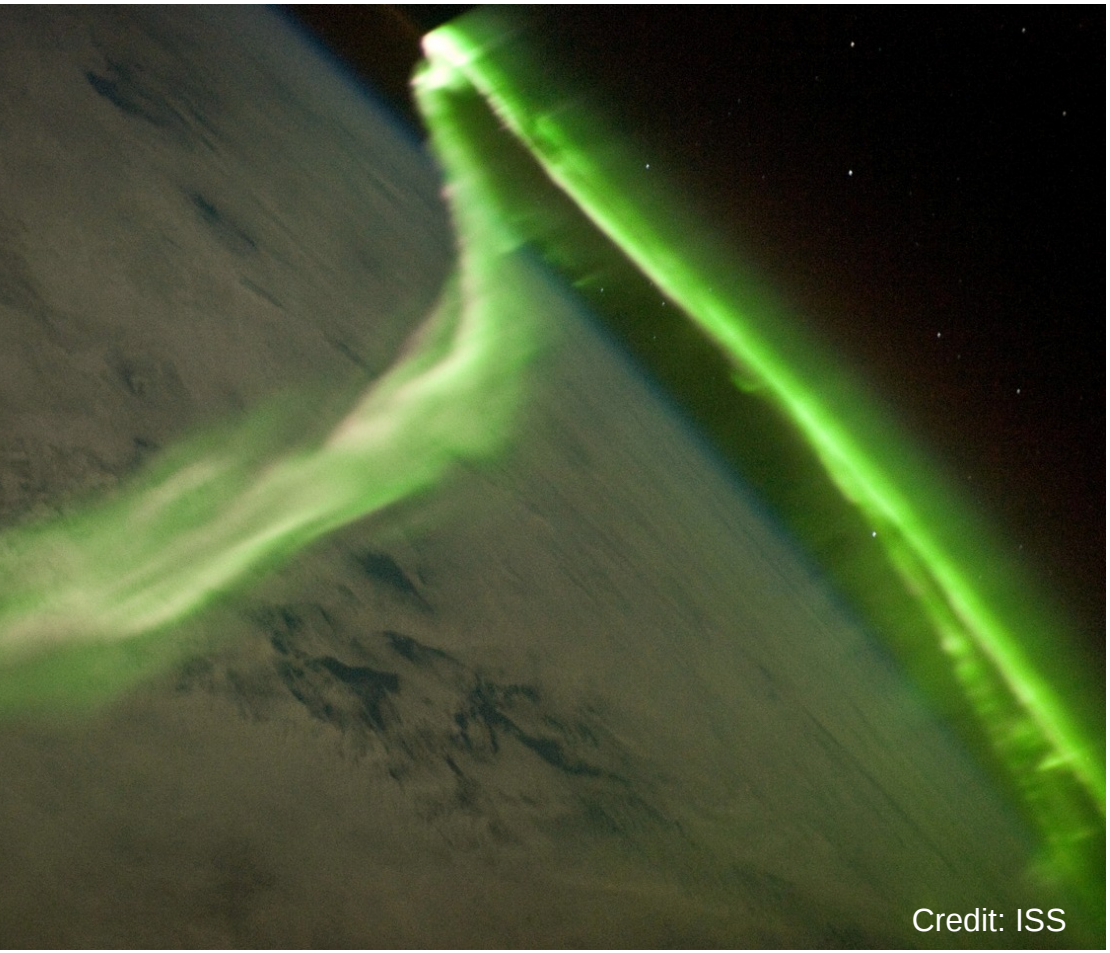
Main user groups of CPOS

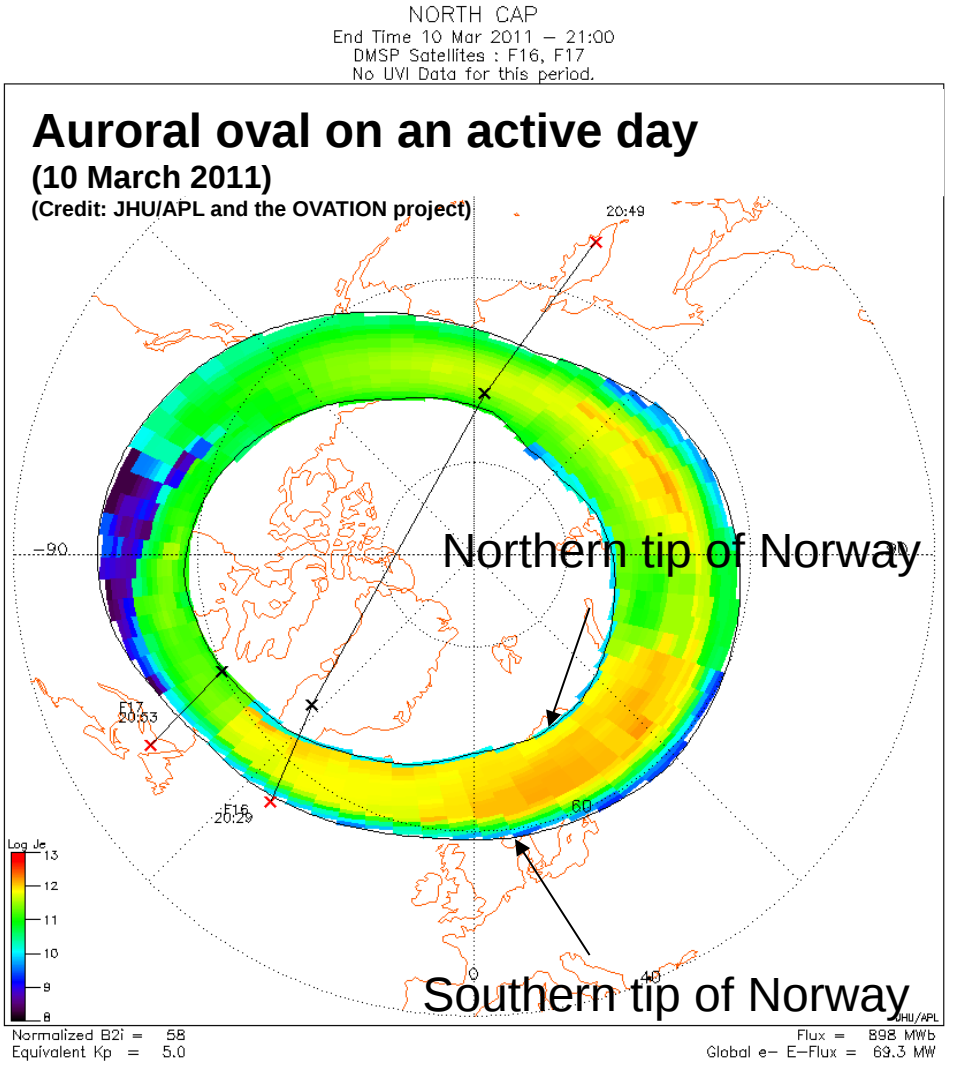
Example of use: Mapping of rail network

There is roughly 4000 km of train tracks in Norway.
The national rail company want to map the accurate position of the tracks.
NMA is involved in a pilot project to determine how to best do this using GNSS.

The Auroral Oval

A visible space weather phenomenon





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Ionosphere monitoring service

seSolstorm

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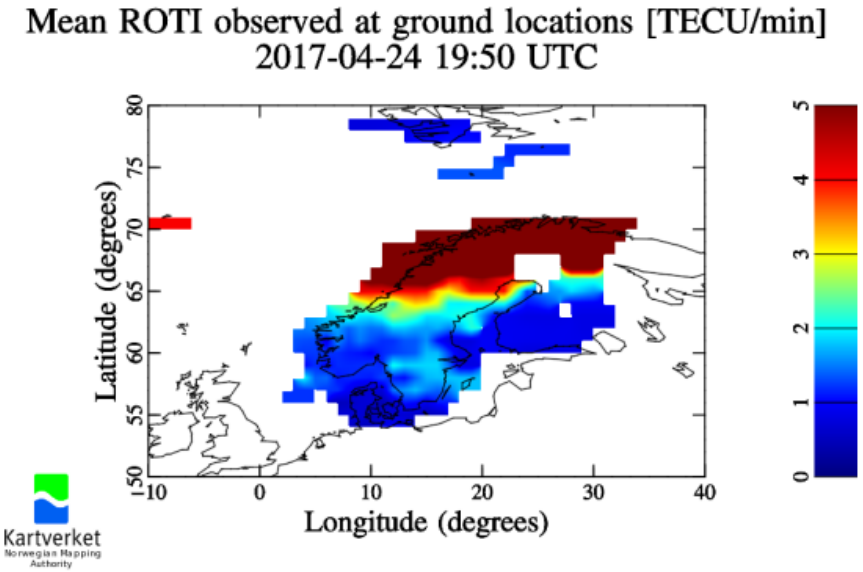
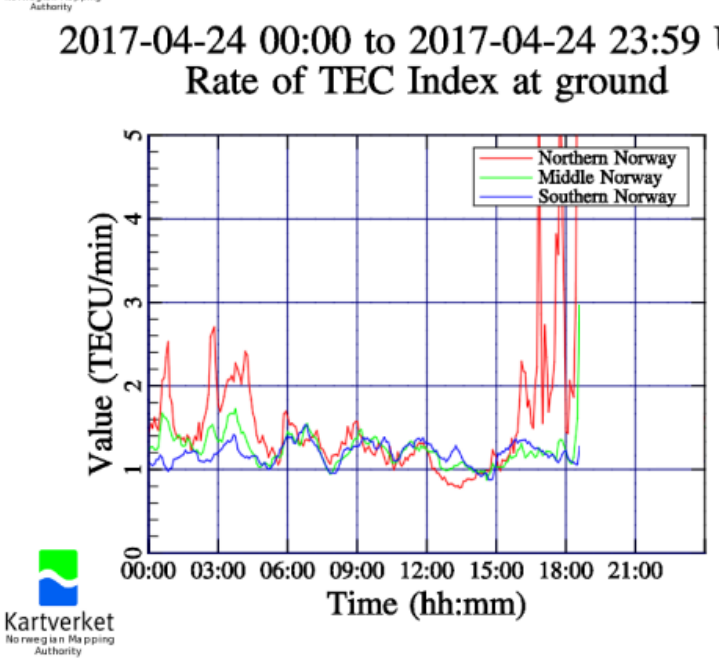
Nå Arkiv Hjelp Om seSolstorm



Forstyrrelser på bakken

Figuren viser hvilke områder på bakken som er påvirket av ionosfæreforstyrrelser (ionosfære). I disse områdene kan man forvente problemer med å gjøre GNSS-målinger (GNSS).

Fargeskalaen går fra blått til rødt, hvor blått er rolige forhold og rødt er store forstyrrelser. En ny figur produseres hvert 5. minutt. I figuren er det brukt UTC tid (UTC)



Tidsserie for forstyrrelser på bakken

Figuren viser siste døgns ionosfæreaktivitet for tre regioner. Regionene er :

- Sør-Norge: 57-62 grader nord (blå linje)
- Midt-Norge: 62-67 grader nord (grønn linje)
- Nord-Norge: 67-72 grader nord (rød linje)

En ny figur produseres hver time. I figuren er det brukt UTC tid (UTC)

Skalaen er som følger:

- 0-1 TECU/min - lav aktivitet
- 1-3 TECU/min - moderat aktivitet
- 3-5 TECU/min - høy aktivitet
- 5+ TECU/min - meget høy aktivitet

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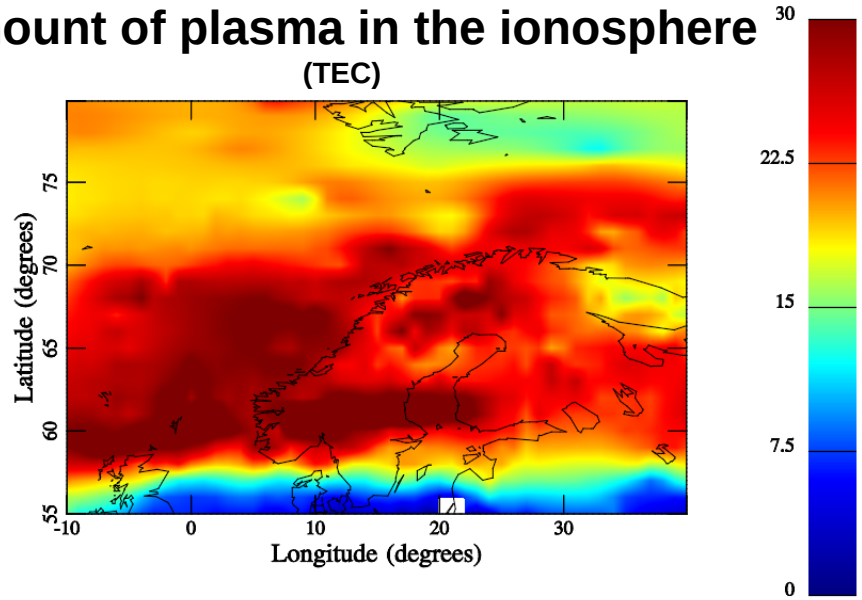
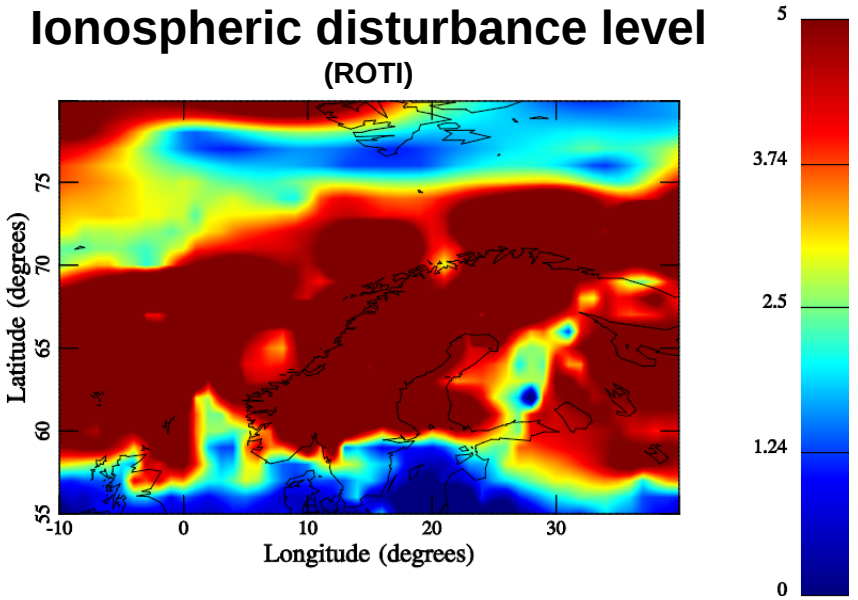
An example of ionosphere disturbances

2011-10-24 23:30 UT

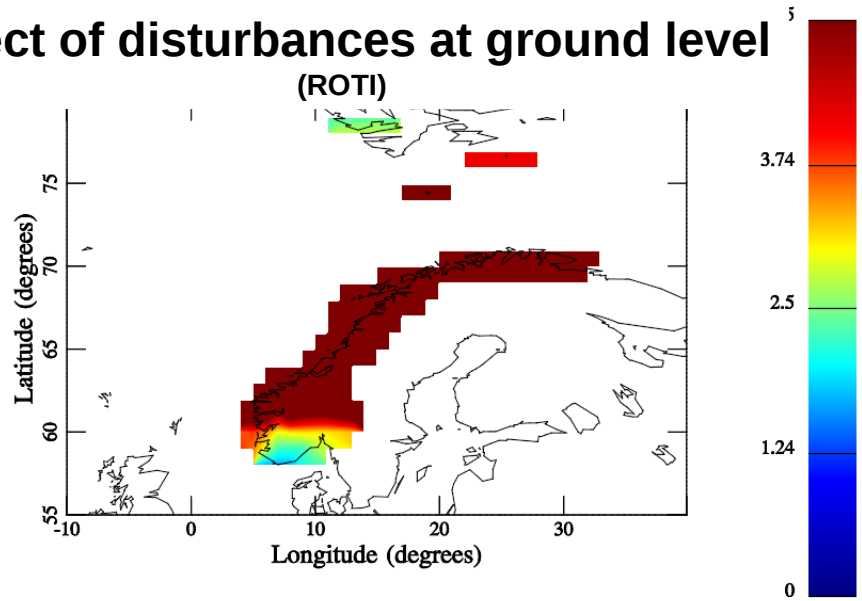
Amount of plasma in the ionosphere (TEC)



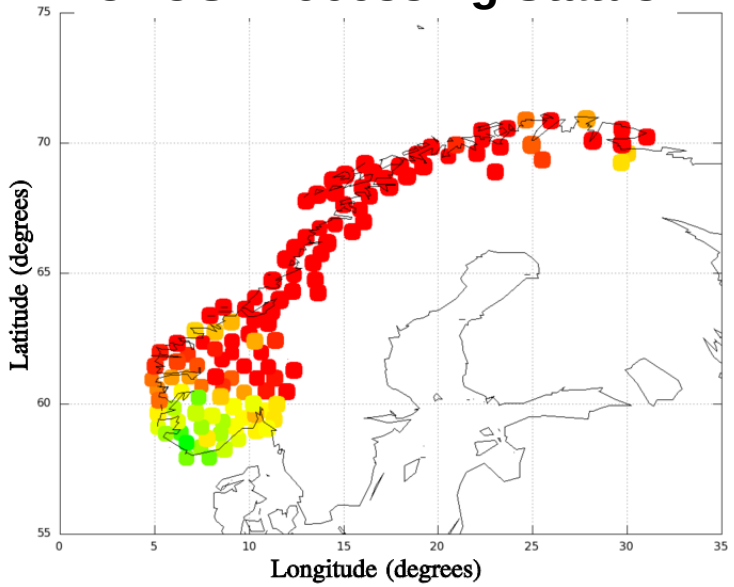
Ionospheric disturbance level (ROTI)



Effect of disturbances at ground level (ROTI)



CPOS Processing Status



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